



# Advancements in DXA Body Composition Analysis

Metabolic Phenotyping with CoreScan



## Metabolic Phenotyping

The classical definition of obesity is the accumulation of excess adipose tissue (fat) to the point where health is negatively impacted.<sup>1</sup> Because it has historically been difficult to measure the amount of fat in the body, physicians have relied on indices such as body mass index (BMI). Measurement of BMI is attractive to clinicians because it is cost effective; however, BMI is not always a reliable indicator of metabolic disease. In fact, studies have shown that 30% of individuals with obese BMI are metabolically healthy, and 20% of subjects with healthy BMI have metabolic disease.<sup>2</sup> Better identification of metabolic risk requires that we look beyond BMI and consider metabolic phenotyping based on body composition measures.

Phenotyping is a term that describes the process of grouping individuals based on measurable traits. For example, within any given BMI category, several metabolic phenotypes can be defined based on where body fat is located. These phenotypes have different risks of developing cardiometabolic disease. A phenotyping approach allows us to move beyond the shortcomings of BMI as a cardiometabolic risk indicator.

## Visceral Fat

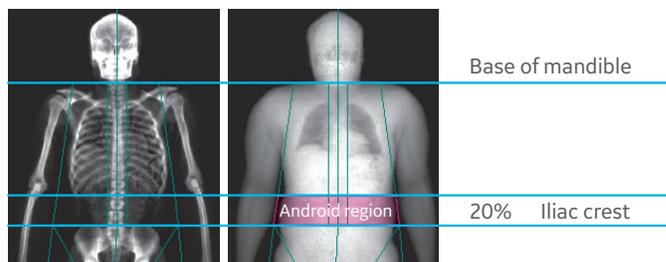
Visceral adipose tissue (VAT), or the fat that accumulates deep within the abdomen, has been associated with the abdominally obese phenotype – one likely to develop cardiometabolic disease.<sup>3</sup> While VAT only accounts for approximately 10% of total body fat, it lies deeper in the abdomen – inside the intra-abdominal cavity. VAT is highly vascularized, contains large fat cells, and secretes disproportionate amounts of inflammation markers into the blood circulation relative to subcutaneous adipose tissue (SAT). This, combined with the location of the VAT, which provides it direct access to the liver, implicate VAT as a pathogenic fat depot.<sup>4</sup>

Numerous clinical studies have shown statistically significant associations between VAT and cardiometabolic disease including the Framingham Heart Study,<sup>5</sup> the Dallas Heart Study,<sup>6</sup> Health Aging and Body Composition (Health ABC),<sup>7</sup> and the Japanese American Community Diabetes Study.<sup>8</sup> These studies, which span a wide variety of gender, age, and ethnic background all show associations between VAT and cardiometabolic disease.

## CoreScan Measurement

While the weight of the evidence suggests that VAT is an important measurement to make in assessing obesity, routine use has been limited by cost and access to CT or MRI, which have been the research tools for measuring VAT.<sup>9</sup> Recently, a dual-energy X-ray absorptiometry (DXA) based VAT measurement approach, CoreScan,<sup>™</sup> has been developed. This automated tool can be conducted on standard DXA equipment and is derived from a total body scan where X-ray exposure is less than the equivalent of one day's natural background radiation.<sup>10</sup> CoreScan has the potential to greatly increase the reach of VAT as a metabolic phenotyping tool.

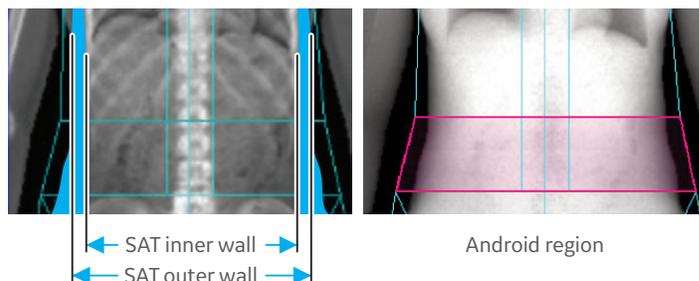
**Figure 1:** The Android region over the abdomen of a total body DXA scan is highlighted.



The CoreScan algorithm computes VAT within the Android region of a total body DXA scan. The Android region, located over the abdomen, is roughly 10 cm in height, extending from iliac crest towards the head a distance that is 20% of the distance from the iliac crest to the base of the mandible (Figure 1). The CoreScan algorithm works through detection of two key parameters: the width of the SAT layer on the lateral aspects of the abdomen (Figure 2a), and the anterior-posterior thickness of the abdomen (Figure 2b), which can be attained using the DXA tissue attenuation image. A simple geometric model using these measures is used to estimate the android SAT. VAT is computed by subtracting the android SAT from the total android fat. The CoreScan algorithm was developed using paired DXA and volumetric CT images from close to 350 subjects from three clinical sites. This sample contains men and women over a wide range of age and BMI.

**Figure 2a:** DXA planar image.<sup>7</sup>

**Figure 2b:** Tissue attenuation image.



## CoreScan Validation and Accuracy

CoreScan was validated using an independent data set acquired at Oregon Health & Sciences University (OHSU) in Portland, OR.<sup>11</sup> The validation study was performed on 109 adult men and women, ages 18 – 90 years, representing a wide range of BMI values (18.5 – 40 kg/m<sup>2</sup>) that were assessed with both DXA and CT within a one hour fasting state. The descriptive statistics of the study population are shown in Table 1.

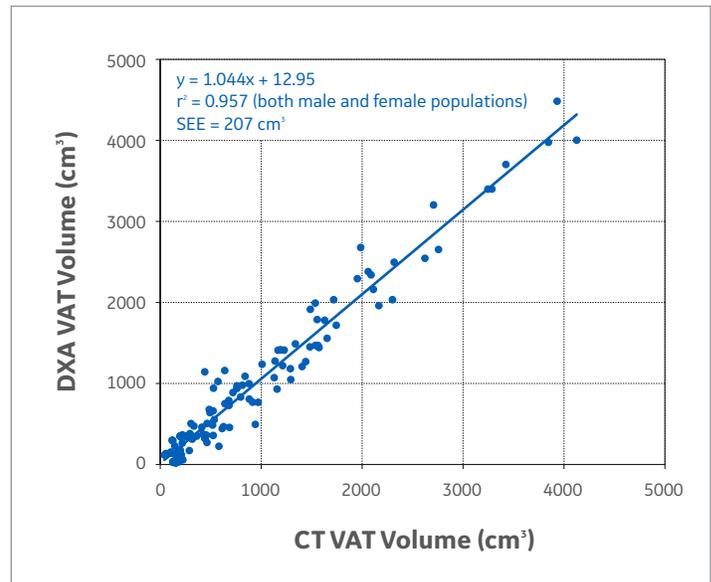
**Table 1:** Descriptive statistics of the OHSU validation study.

| Variable                           | Female (n = 61) | Male (n = 48) |
|------------------------------------|-----------------|---------------|
| Age (yrs)                          | 48.5 ± 14.3     | 50.8 ± 13.4   |
| Height (cm)                        | 164.5 ± 6.7     | 177.9 ± 6.7   |
| Weight (kg)                        | 72.5 ± 14.4     | 84.8 ± 14.5   |
| BMI (kg/m <sup>2</sup> )           | 26.7 ± 4.7      | 26.7 ± 3.5    |
| DXA Android Fat (cm <sup>3</sup> ) | 2310 ± 1450     | 2334 ± 1130   |
| DXA SAT (cm <sup>3</sup> )         | 1650 ± 810      | 1010 ± 469    |
| DXA VAT (cm <sup>3</sup> )         | 800 ± 960       | 1382 ± 946    |
| CT VAT (cm <sup>3</sup> )          | 730 ± 870       | 1337 ± 900    |

DXA images were acquired using a Lunar iDXA™ running enCORE software using a standard total body (TB) scan. Placement of the Android region along with calculation of VAT was performed automatically by the software. Volumetric CT images over 15 cm of the abdomen were acquired on the same subjects. VAT was quantified based on subject-specific VAT threshold, set as 2SD from the mean Hounsfield units of a representative VAT sample. VAT was reported as the sum of all slices across a region equivalent to the DXA Android region.

Figure 3 shows the correlation between DXA measure of VAT volume and CT. The coefficient of determination ( $r^2$ ) for regression of CT on DXA values was 0.957 for the combination men and women. The average Bland-Altman bias was +57 cm<sup>3</sup> for males, with 95% of subjects within -355 to +468 cm<sup>3</sup> difference between CT and DXA.

**Figure 3:** Correlation between CoreScan and CT.



## Summary

CoreScan is the first readily available method to quantify VAT. CoreScan has been validated across a broad population of adults. The CoreScan application may be useful in helping physicians to manage cardiometabolic risk in patients with hypertension, type 2 diabetes, impaired fasting glucose, impaired glucose tolerance, dyslipidemia and metabolic syndrome. CoreScan may be especially useful to help characterize risk where standard indices fall short in both the normal and overweight population.

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† Figure adapted from Del Rio et al., European Congress on Obesity, 2007.



## Imagination at work

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